

WHAT IS CLAIMED IS:

1. A sintered ceramic body made from a starting powder mixture that includes silicon nitride powder, wherein the starting silicon nitride powder  
5 comprising less than or equal to about 5 weight percent beta-silicon nitride, the ceramic body comprising:  
a two phase composite comprising alpha prime SiAlON phase and beta prime SiAlON phase, and the alpha prime SiAlON phase containing ytterbium therein;  
10 and  
the alpha prime SiAlON phase being present in an amount greater than or equal to about 25 weight percent of the two phase composite.
2. The sintered ceramic body of claim 1  
15 wherein the beta prime SiAlON phase being of the formula  $\text{Si}_{6-z}\text{Al}_2\text{O}_2\text{N}_{8-z}$  wherein z is greater than 0.3 and less than 1.5.
3. The sintered ceramic body of claim 2 wherein z is greater than 0.7 and less than 1.5.
- 20 4. The sintered ceramic body of claim 2 wherein z is greater than 0.3 and less than 0.6.
5. The sintered ceramic body of claim 1 wherein the beta prime SiAlON phase being present in an amount between about 15 weight percent and about 75  
25 weight percent of the two phase composite.
6. The sintered ceramic body of claim 1 further including an intergranular phase.
7. The sintered ceramic body of claim 6 wherein the intergranular phase including a glassy  
30 phase.

8. The sintered ceramic body of claim 6 wherein the intergranular phase including an intergranular crystalline phase.

5 9. The sintered ceramic body of claim 8 wherein the intergranular crystalline phase does not include a B-phase of the formula  $\text{Yb}_2\text{SiAlO}_5\text{N}$  or a Wollastonite phase.

10 10. The sintered ceramic body of claim 6 wherein the intergranular phase including an intergranular crystalline phase and a glassy phase.

11. The sintered ceramic body of claim 1 wherein the alpha prime SiAlON phase being present in an amount between about 60 weight percent and about 80 weight percent of the two phase composite.

15 12. The sintered ceramic body of claim 1 wherein the alpha prime SiAlON phase being present in an amount between about 45 weight percent and about 85 weight percent of the two phase composite.

20 13. The sintered ceramic body of claim 1 wherein the alpha prime SiAlON phase having an "a" unit cell dimension and a "c" unit cell dimension, and the ratio (c/a) of the "a" unit cell dimension to the "c" unit cell dimension for the alpha prime SiAlON phase being between about .725 and about .730.

25 14. The sintered ceramic body of claim 13 wherein the ratio c/a for the alpha prime SiAlON phase ranges between about .726 and about .729.

30 15. The sintered ceramic body of claim 1 wherein the starting silicon nitride powder contains less than or equal to about 2 weight percent beta-silicon nitride.

16. The sintered ceramic body of claim 1 wherein the starting silicon nitride powder contains essentially zero weight percent beta-silicon nitride.

17. The sintered ceramic body of claim 1  
5 wherein the starting silicon nitride powder comprises about 100 weight percent alpha-silicon nitride.

18. The sintered ceramic body of claim 1 wherein the alpha prime SiAlON phase further containing one or more of erbium, thulium, lutetium, and scandium.

19. A ceramic composition comprising:  
a two phase composite of an alpha prime SiAlON phase and a beta prime SiAlON phase;  
the alpha prime SiAlON phase having ytterbium therein;  
15 the alpha prime SiAlON phase being present in an amount between about 45 weight percent and about 85 weight percent of the two phase composite;  
and  
an intergranular phase.

20. The ceramic composition of claim 19 wherein the beta prime SiAlON phase being of the formula  $\text{Si}_{6-z}\text{Al}_z\text{O}_z\text{N}_{8-z}$  wherein z is greater than 0.3 and less than 1.5.

21. The ceramic composition of claim 19  
25 wherein the intergranular phase including an intergranular crystalline phase and a glassy phase.

22. The ceramic composition of claim 19 wherein the intergranular crystalline phase does not include a B-phase of the formula  $\text{Yb}_2\text{SiAlO}_5\text{N}$  or a  
30 Wollastonite phase.

23. The ceramic composition of claim 19 wherein the alpha prime SiAlON phase being present in

an amount between about 60 weight percent and about 80 weight percent of the two phase composite.

24. The ceramic composition of claim 19 wherein the alpha prime SiAlON phase further contains  
5 in addition to ytterbium one or more rare earth elements wherein each of the rare earth elements for a valance of +3 and a coordination number of 6 has an effective ionic radius equal to less than .900 Angstroms.

10 25. The ceramic composition of claim 19 wherein the alpha prime SiAlON phase further contains one or more of the following elements: erbium, thulium, lutetium and scandium.

26. A ceramic composition consisting  
15 essentially of:

an alpha prime SiAlON phase and a beta prime SiAlON phase, and the alpha prime SiAlON phase having ytterbium therein;

20 the alpha prime SiAlON phase being present in an amount between about 45 weight percent and about 85 weight percent of the total content of the alpha prime SiAlON phase and the beta prime SiAlON phase;

25 the beta prime SiAlON phase being present in an amount between about 15 weight percent and about 55 weight percent of the total content of the alpha prime SiAlON phase and the beta prime SiAlON phase; and

30 an intergranular phase wherein the intergranular phase includes one or more of a glassy phase and an intergranular crystalline phase.

27. The ceramic composition of claim 26 wherein the alpha prime SiAlON phase being present in an amount between about 60 weight percent and about

70 weight percent of the total content of the alpha prime SiAlON phase and the beta prime SiAlON phase and the beta prime SiAlON phase being present in an amount between about 30 weight percent and about 40 weight percent of the total content of the alpha prime SiAlON phase and the beta prime SiAlON phase.

28. The ceramic composition of claim 26 wherein the beta prime SiAlON phase being of the formula  $\text{Si}_{6-z}\text{Al}_z\text{O}_2\text{N}_{8-z}$  wherein  $z$  is greater than 0.3 and less than 1.5.

29. The ceramic composition of claim 26 wherein the alpha prime SiAlON phase having an "a" unit cell dimension and a "c" unit cell dimension, and the ratio (c/a) of the "a" unit cell dimension to the "c" unit cell dimension for the alpha prime SiAlON phase being between about .725 and about .730.

30. The ceramic composition of claim 29 wherein the ratio c/a for the alpha prime SiAlON phase ranges between about .726 and about .729.

31. A sintered ceramic body made from a starting powder mixture that includes silicon nitride powder wherein starting silicon nitride powder comprising less than or equal to about 2 weight percent beta-silicon nitride, the body comprising:  
a two phase composite of alpha prime SiAlON phase and beta prime SiAlON phase, and the alpha prime SiAlON phase having ytterbium therein;  
the alpha prime SiAlON phase being present in an amount greater than or equal to about 25 weight percent of the two phase composite; and  
an intergranular phase.

32. The sintered ceramic body of claim 31 having a fracture toughness of greater than or equal to about 6.0 MPam<sup>1/2</sup>.

5 33. The sintered ceramic body of claim 31 having a fracture toughness of greater than or equal to about 7.0 MPam<sup>1/2</sup>.

34. The sintered ceramic body of claim 31 having a fracture toughness of greater than or equal to about 8.0 MPam<sup>1/2</sup>.

10 35. The sintered ceramic body of claim 31 wherein the intergranular phase including ytterbium aluminum garnet.

36. The sintered ceramic body of claim 31 wherein the intergranular phase including a YbAM  
15 crystalline phase.

37. The sintered ceramic body of claim 31 wherein the intergranular phase including a N-YbAM crystalline phase.

20 38. The sintered ceramic body of claim 31 wherein the intergranular phase including a N-YbAM crystalline phase and a YbAM crystalline phase.

39. The sintered ceramic body of claim 31 wherein the intergranular phase including a glassy phase.

25 40. The sintered ceramic body of claim 31 wherein the beta prime SiAlON phase being of the formula Si<sub>6-2</sub>Al<sub>2</sub>O<sub>2</sub>N<sub>8-2</sub> wherein z is greater than 0.3 and less than 1.5.

30 41. The sintered ceramic body of claim 31 wherein the alpha prime SiAlON phase having an "a" unit cell dimension and a "c" unit cell dimension, and the

ratio (c/a) of the "a" unit cell dimension to the "c" unit cell dimension for the alpha prime SiAlON phase being between about .725 and about .730.

42. The sintered ceramic body of claim 41  
5 wherein the ratio c/a for the alpha prime SiAlON phase ranges between about .726 and about .729.

43. A ceramic composition comprising:  
a two phase composite of an alpha prime  
SiAlON phase and a beta prime SiAlON phase;  
10 the alpha prime SiAlON phase having  
therein one or more selected from the group consisting  
of ytterbium, erbium, thulium and lutetium;  
the alpha prime SiAlON phase being  
present in an amount between about 45 weight percent  
15 and about 85 weight percent of the two phase composite;  
and  
an intergranular phase.

44. The ceramic composition of claim 43  
wherein the alpha prime SiAlON phase being present in  
20 an amount greater than or equal to about 50 weight  
percent of the two phase composite.

45. A sintered ceramic body made from a  
starting powder mixture that includes silicon nitride  
powder, wherein the starting silicon nitride powder  
25 comprising less than or equal to about 2 weight percent  
beta-silicon nitride, the ceramic body comprising:  
a two phase composite comprising alpha  
prime SiAlON phase containing ytterbium therein and  
beta prime SiAlON phase; and  
30 the composition of the ceramic body  
falling above the line x-x in FIG. 5.

46. The sintered ceramic body of claim 45  
wherein the two phase composite comprises between about

30 weight percent and about 40 weight percent alpha prime SiAlON phase, and between about 60 weight percent and about 70 weight percent beta prime SiAlON phase.

47. The sintered ceramic body of claim 45  
5 wherein the starting silicon nitride powder comprises about 0 weight percent beta-silicon nitride.

48. A sintered ceramic body made from a starting powder mixture that includes silicon nitride powder, wherein the starting silicon nitride powder  
10 comprising less than or equal to about 5 weight percent beta-silicon nitride, the ceramic body comprising:

a two phase composite comprising alpha prime SiAlON phase and beta prime SiAlON phase, and the alpha prime SiAlON phase containing one or more rare  
15 earth elements therein, and wherein for a valence of +3 and a coordination number of 6 the effective ionic radius of each one of the rare earth elements equals less than 0.900 Angstroms; and

the alpha prime SiAlON phase being  
20 present in an amount greater than or equal to about 25 weight percent of the two phase composite.

49. The sintered ceramic body of claim 48 wherein the rare earth element comprising one or more selected from the group consisting of erbium, thulium,  
25 lutetium, scandium and ytterbium.

50. The sintered ceramic body of claim 48 wherein the rare earth element comprising ytterbium.